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NATIONAL DAM SAFETY PROGRAM. GWENMIL LAKE DAM (MO 31210), UPPER--ETC(U)
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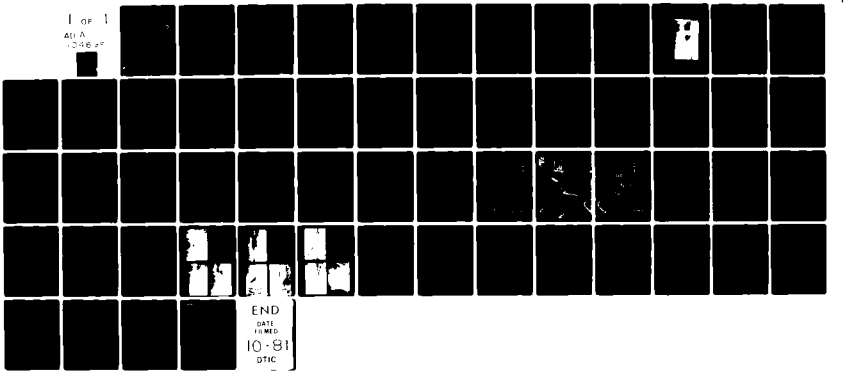

3 UPPER MISSISSIPPI - KASKASKIA - ST. LOUIS BASIN

2 GWENMIL LAKE DAM

4 JEFFERSON COUNTY, MISSOURI

MO 31210

5 PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

United States Army
Corps of Engineers
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St. Louis District

PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

APRIL 1981

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This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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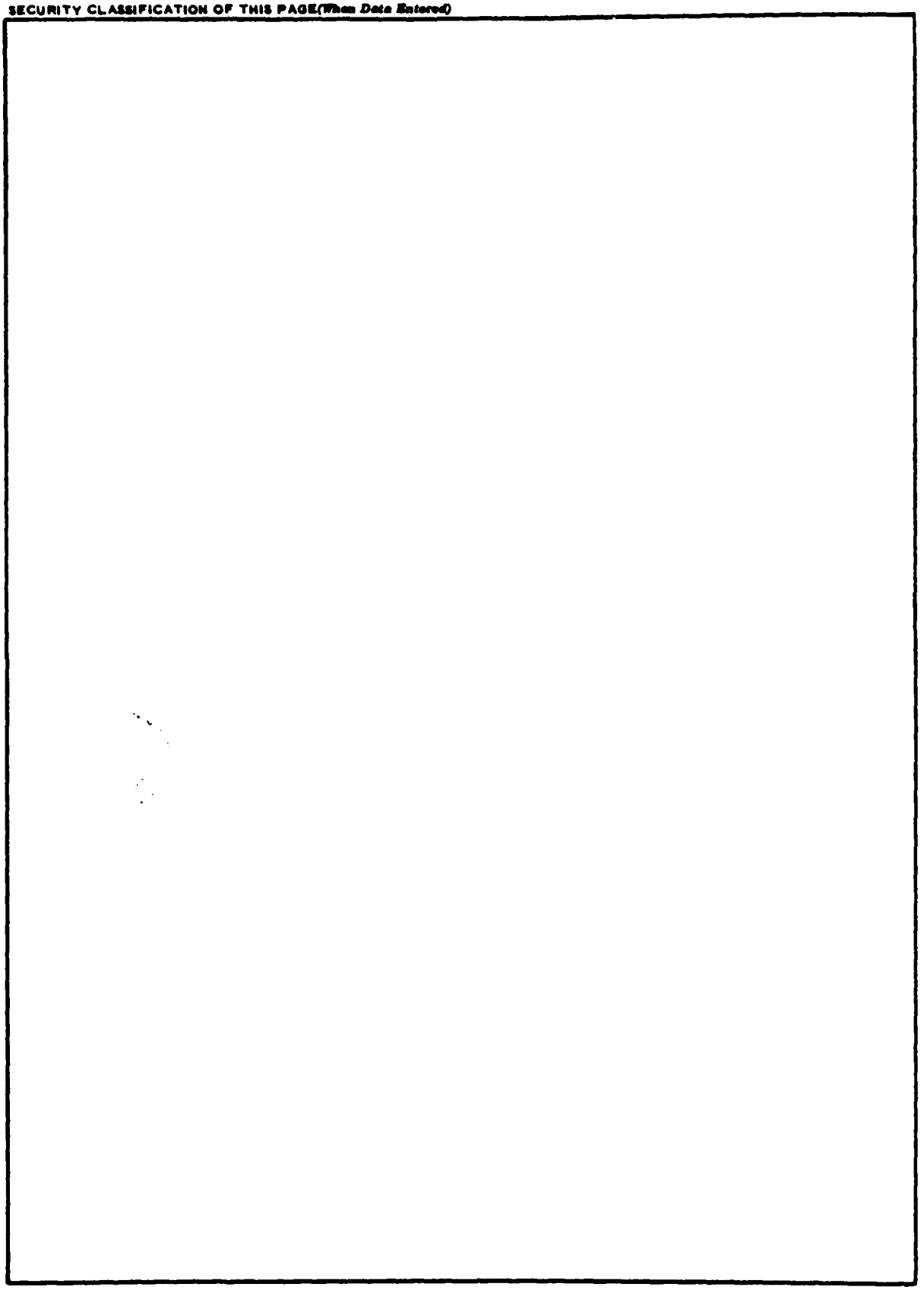

UPPER MISSISSIPPI - KASKASKIA - ST. LOUIS BASIN

GWENMIL LAKE DAM

JEFFERSON COUNTY, MISSOURI

MO 31210

PHASE 1 INSPECTION REPORT
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PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

APRIL 1981

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

REPLY TO ATTENTION OF

LMSED-P

SUBJECT: Gwenmil Lake Dam, MO 31210

This report presents the results of field inspection and evaluation of the Gwenmil Lake Dam, MO 31210. It was prepared under the National Program of Inspection of Non-Federal Dams.

SUBMITTED BY: SIGNED — 19 JUN 1981

Chief, Engineering Division — Date

APPROVED BY: SIGNED — 22 JUN 1981

Colonel, CE, District Engineer — Date

GWENMIL LAKE DAM

MISSOURI INVENTORY NO. 31210

JEFFERSON COUNTY, MISSOURI

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY:

HORNER & SHIFRIN, INC.
5200 OAKLAND AVENUE
ST. LOUIS, MISSOURI 63110

FOR:

U. S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS

APRIL 1981

HS-8088

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Gwenmil Lake Dam
State Located:	Missouri
County Located:	Jefferson
Stream:	Tributary of Isum Creek
Date of Inspection:	7 November 1980

The Gwenmil Lake Dam, which according to the St. Louis District, Corps of Engineers, is of significant hazard potential, was visually inspected by engineering personnel of Horner & Shifrin, Inc., Consulting Engineers, St. Louis, Missouri. The purpose of this inspection was to assess the general condition of the dam with respect to safety and, based upon this inspection and available data, determine if the dam poses an inordinate danger to human life or property. Evaluation of this dam was performed in accordance with the "Phase I" investigation procedures prescribed in "Recommended Guidelines for Safety Inspection of Dams", dated May 1975.

The following summarizes the findings of the visual inspection and the results of certain hydrologic/hydraulic investigations performed under the direction of the inspection team. Based on the visual inspection, the present general condition of the dam is considered to be somewhat less than satisfactory. Several items were noticed during the inspection which are considered to have an adverse effect on the overall safety and future operation of the dam. These items include trees and areas of dense brush on the downstream face of the embankment, an excessively steep (as much as 1.0v on 1.5h) downstream slope, erosion of the grass covered upstream face of the

dam, and a dense growth of cattails within the reservoir just upstream of the spillway.

According to the criteria set forth in the recommended guidelines, the magnitude of the spillway design flood for the Gwenmil Lake Dam, which, according to Table 1 of the guidelines, is classified as small in size, is specified, according to Table 3 of the guidelines for a dam of significant hazard potential and small size, to be a minimum of the 100-year frequency flood and can be, depending upon the degree of risk involved, as much as one-half the Probable Maximum Flood (PMF). The 100-year frequency flood is the flood magnitude expected to be exceeded, on the average, once in 100 years. It may also be expressed as an exceedence frequency with a 1 percent chance of being exceeded in any given year. The Probable Maximum Flood (PMF) is the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. Considering the fact that a relatively small volume of water is impounded by the dam, that the flood plain downstream of the dam is fairly broad, that there are but three dwellings (two of which are well above the streambed) and a non-high hazard potential dam within the flood damage zone, it is recommended that the spillway for this dam be designed for the 100-year frequency flood.

Results of a hydrologic/hydraulic analysis indicated that the spillway is adequate to pass lake outflow resulting from the 1 percent chance (100-year frequency) flood and, for all practical purposes, the lake outflow resulting from a storm of one-half PMF magnitude without overtopping the dam. According to the St. Louis District, Corps of Engineers, the length of the downstream damage zone, should failure of the dam occur, is estimated to be two miles. Accordingly, within the potential damage zone are three dwellings, a dam (MO 30431), and two farm buildings. Dam No. 30431, according to the Corps of Engineers, also has a significant (less than high) hazard potential classification. No determination was made whether or not failure of Dam No. 30431 would occur during any of the flood events or conditions of overtopping investigated herein.

A review of available data did not disclose that seepage or stability analyses of the dam were performed. This is considered a deficiency and should be rectified.

It is recommended that the Owner take the necessary action in the near future to correct or control the deficiencies and safety defects reported herein.

Ralph E. Sauthoff
P. E. Missouri E-19090

Albert B. Becker, Jr.
P. E. Missouri E-9168

OVERVIEW GWENMILL LAKE DAM

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

GWENMIL LAKE DAM - MO 31210

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PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

GWENMIL LAKE DAM - MO 31210

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, dated 8 August 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, directed that a safety inspection of the Gwenmil Lake Dam be made.

b. Purpose of Inspection. The purpose of this visual inspection was to make an assessment of the general condition of the dam with respect to safety and, based upon available data and this inspection, determine if the dam poses an inordinate danger to human life or property.

c. Evaluation Criteria. This evaluation was performed in accordance with the "Phase I" investigation procedures as prescribed in "Recommended Guidelines for Safety Inspection of Dams", Appendix D to "Report to the Chief of Engineers on the National Program of Inspection of Non-Federal Dams", dated May 1975.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances. The Gwenmil Lake Dam is an earthfill type embankment rising approximately 29 feet above the natural streambed at the downstream toe of the barrier. The embankment has an upstream slope (above the waterline) of approximately 1v on 3.0h, a crest width of about 17 feet, and a downstream slope on the order of 1v on 2.0h, although it becomes somewhat less steep, 1v on 3.1h, near the base and, at the location of the original stream channel at an elevation approximately 22 feet below the dam crest, the downstream slope steepens to about 1v on 1.5h. The

length of the dam is approximately 341 feet. A plan and profile of the dam are shown on Plate 3 and a cross-section of the dam is shown on Plate 4. At normal pool elevation, the reservoir impounded by the dam encompasses approximately 3.0 acres. According to Mrs. Mildred L. Cook, the original owner of the dam, a pipe about 3 inches in diameter with a gate on the downstream end was provided to dewater the lake. The drain pipe could not be located at the time of inspection. An overview photo of the dam is shown following the preface at the front of the report.

The spillway, an earthen section, is located at the left, or east, abutment. A 12 inch wide concrete retaining wall approximately 24.2 feet long and about 1.7 feet high (above ground level on the lake side of the wall) is located at the upstream end of the spillway. An earth dam on the right side of the spillway downstream of the crest, served to confine flow to the channel and protect the dam. At the downstream end of the spillway, a low 6-inch wide concrete retaining wall has been constructed, apparently, to prevent erosion of the spillway channel, and to direct flow to an excavated rip rap channel located beyond the toe of the dam. However, erosion has created a gully or shallow ditch, adjacent to the left side of the wall and it appears as though spillway flows have followed the gully toward a natural drainage swale located just downstream and parallel to the intended outlet channel. The excavated spillway outlet channel and the natural drainage swale join the original stream channel on which the dam was built at a point approximately 35 feet and 50 feet, respectively, downstream of the toe of the dam. A profile and cross-section of the spillway are shown on Plate 3.

b. Location. The dam is located on an unnamed tributary of Isum Creek within the Gwenmil Subdivision, a residential development. Gwenmil Subdivision is located just south of Hillsboro Road, about 2.1 mile west of the intersection of Hillsboro Road and Dublin Creek Road, and approximately 3 miles east of Cedar Hill, Missouri, as shown on the Regional Vicinity Map, Plate 1. The dam is located in the southeast one-quarter of Section 29, Township 42, North, Range 4 East, within Jefferson County.

c. Size Classification. The size classification based on the height of the dam and storage capacity, is categorized as small (see Table 1,

Recommended Guidelines for Safety Inspection of Dams). A small size dam is classified, according to the guidelines, as having a height less than 40 feet, but greater than or equal to 25 feet and/or a storage capacity less than 1,000 acre-feet, but greater than or equal to 50 acre-feet.

d. Hazard Classification. The Gwenmil Lake Dam, according to the St. Louis District, Corps of Engineers, has a significant hazard potential, meaning that if the dam should fail, there may be loss of life, damage to isolated homes, secondary highways or minor railroads, or cause interruption of use or service of relatively important public utilities. The estimated flood damage zone, should failure of the dam occur, as determined by the St. Louis District, extends two miles downstream of the dam. Within the possible flood damage zone are three dwellings, a dam (MO 30431), and two farm buildings. Dam No. 30431, according to the Corps of Engineers, also has a significant (less than high) hazard potential classification. Those features lying within the downstream damage zone reported by the Corps of Engineers, St. Louis District, were verified by the inspection team.

e. Ownership. The lake and dam are owned by Gwenmil Lake Subdivision, Inc., an association of home owners who reside within the Gwenmil Subdivision. Mr. Edward Ward is the current president of the association's board of trustees. Mr. Ward's address is Route 1, Box 41A, Cedar Hill, Missouri 63016.

f. Purpose of Dam. The dam impounds water for recreational use.

g. Design and Construction History. According to Mildred L. Cook, Mrs. Cook and her husband, Glen H. Cook (deceased), were the original owners of the dam, the dam was constructed during the fall of 1957 by the Ficken Material and Excavating Company of Cedar Hill, Missouri. Mr. Walter Ficken, president of the construction company at the time the dam was built, reported that the dam had been "laid out" by others (unknown party) prior to their beginning work, but that they, the Ficken Company, did complete the dam as originally planned. No engineering data relative to the design or records of the construction of the dam are known to exist.

h. Normal Operational Procedure. The lake level is unregulated. Lake outflow is governed by the capacity of an excavated earth type spillway.

1.3 PERTINENT DATA

a. Drainage Area. The area tributary to the lake is a residential type subdivision development consisting of approximately 25 percent impervious area. The watershed above the dam amounts to approximately 15 acres. The watershed area is outlined on Plate 2.

b. Discharge at Damsite.

(1) Estimated known maximum flood at damsite ... 31 cfs* (W.S.Elev. 635.6)
(2) Spillway capacity ... 94 cfs (W.S.Elev. 636.2)

c. Elevation (Ft. above MSL). Unless otherwise indicated, the following elevations were determined by survey and are based on topographic data shown on the 1954 Belew Creek, Missouri, Quadrangle Map, 7.5 Minute Series (photorevised 1968 and 1974).

(1) Observed pool ... 632.8
(2) Normal pool ... 635.0
(3) Spillway crest ... 635.0
(4) Maximum experienced pool ... 635.6*
(5) Top of dam ... 636.2 (Min.)
(6) Streambed at centerline of dam ... 610± (Est.)
(7) Maximum tailwater ... Unknown
(8) Observed tailwater ... None

d. Reservoir.

(1) Length at normal pool (Elev. 635.0) ... 500 ft.
(2) Length at maximum pool (Elev. 636.2) ... 525 ft.

*Based on an estimate of depth of flow at spillway as observed by Mr. Larry Cook, a resident of Gwenmil Subdivision.

e. Storage.

(1) Normal pool ... 23 ac. ft.
(2) Top of dam ... 27 ac. ft.

f. Reservoir Surface Area.

(1) Normal pool ... 3.0 acres
(2) Top of dam ... 3.4 acre

g. Dam. The height of the dam is defined to be the overall vertical distance from the lowest point of foundation surface at the downstream toe of the barrier, to the top of the dam.

(1) Type ... Earthfill, homogeneous*
(2) Length ... 341 ft.
(3) Height ... 29 ft.
(4) Top width ... 17 ft.
(5) Side slopes
    a. Upstream ... 1v on 3.0h (above waterline)
    b. Downstream ... 1v on 3.1h to 1v on 1.5h (at original stream)
(6) Cutoff ... Core trench*
(7) Slope protection
    a. Upstream ... Grass
    b. Downstream ... Grass

h. Spillway.

(1) Type ... Uncontrolled, earth channel with concrete retaining wall at upstream end
(2) Location ... Left abutment
(3) Crest ... Elevation 635.0 (top of wall)
(4) Approach channel ... Lake
(5) Outlet channel ... Natural drainage swale

*Per Mr. Walter Ficken, dam builder.

i. Emergency Spillway ... None

j. Lake Drawdown Facility. The former owner, Mrs. Mildred L. Cook, reported that a 3-inch diameter pipe, capped at the downstream end, was installed through the dam for the purporse of draining the lake. However, the drain line could not be located during the inspection.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Data relating to the design of the dam were unavailable.

2.2 CONSTRUCTION

As previously stated, the dam was constructed in 1957 by the Ficken Material and Excavating Company. According to Walter H. Ficken, president of the company, a core trench for seepage cutoff was excavated to solid rock along the axis of the dam. Mr. Ficken indicated that the core trench was approximately 10-to-12 feet wide, and that the clay material for backfilling the trench and constructing the embankment was selected from areas to be occupied by the lake. No records of the construction of the dam were available.

2.3 OPERATION

The lake level is uncontrolled and governed by the elevation of the top of a concrete retaining wall located at the upstream end of an excavated earth type spillway. No indication was found that the dam has been overtopped. The former owner, Mrs. Mildred Cook, who has lived within the Gwenmil Subdivision since before the dam was constructed, reported that the dam has never been overtopped. According to Mr. Larry Cook, a resident of the Gwenmil Subdivision, the highest lake level experienced to date occurred about 4 or 5 years ago when a storm produced a depth of flow at the spillway wall estimated to be about 7 inches.

2.4 EVALUATION

a. Availability. Engineering data for assessing the design of the dam and spillway were unavailable.

b. Adequacy. No data available. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety

Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of the Gwenmil Lake Dam was made by Horner & Shifrin engineering personnel, R. E. Sauthoff, Civil Engineer, H. B. Lockett, Hydrologist, and A. B. Becker, Jr., Civil and Soils Engineer, on 7 November 1980. A representative of the Owner was not present during the inspection. An examination of the dam area was also made by an engineering geologist, Jerry D. Higgins, Ph.D., a consultant retained by Horner & Shifrin for the purpose of assessing the site geology. Also examined at the time of the inspection were the areas and features below the dam within the potential flood damage zone. Photographs of the dam taken at the time of the inspection are included on pages A-1 through A-3 of Appendix A. The locations of the photographs taken during the inspection are indicated on Plate 3.

b. Site Geology. Gwenmil Dam is located on an unnamed tributary to Isum Creek, which flows into the Big River approximately two miles to the west. The topography in this area is moderately to gently rolling, and there is about 70 feet of relief between the reservoir bottom and the surrounding drainage divide. The topography becomes more rugged toward the Big River Valley, so that regionally there is about 350 feet of relief. The area is included within the northeastern part of the Ozark Plateaus Physiographic Province, and regionally the bedrock structure dips northeastward into the Illinois Basin.

There are no rock outcrops in the immediate vicinity of the site; however, the reservoir and surrounding uplands are underlain by the Ordovician-age Jefferson City formation. This is a light brown to gray, finely crystalline, argillaceous dolomite. It is generally thin- to medium-bedded and contains both nodular and bedded chert, as well as some thin sandstone layers. Solution enlargement of joints and bedding planes is common, and the contact between bedrock and the overlying soils is generally very irregular as a result of the solution weathering. These solution features are commonly the cause of reservoir leakage when the soil cover is thin.

The soils derived from the Jefferson City formation are reddish-brown to buff-colored, moderately plastic clays, usually mixed with silt on the upland areas (ML-CL, Unified Soil Classification System). In the vicinity of the reservoir, the soils include a noticeable sand component that has probably been derived from the original overlying St. Peter Sandstone formation, that now has been totally removed from the area by erosion. Weathering of thin sandstone lenses within the formation may have added sand to the cla, soils.

No geologic conditions were noted at the site that would be considered to be detrimental to the performance of the reservoir or embankment stability.

c. Dam. The visible portions of the upstream and downstream faces of the dam (see Photos 1, 2 and 3), as well as the dam crest, were inspected and, except for some erosion of the upstream face at the waterline, appeared to be in sound condition. No undue settlement of the crest, sliding or sloughing of the embankment slopes, or misalignment of the dam was noted. For the most part, the downstream face of the dam was covered with dense brush and trees up to 4 inches in diameter. Except for grass about 12 inches high, the upstream face of the dam was unprotected, i.e., no riprap, and erosion (see Photo 9), apparently by wave action or changes in the lake level, had created a near vertical bank up to 12 inches high at the normal waterline. Due to the presence of several dense stands of cattails at the waterline, the upstream face of the dam could not be thoroughly examined, and although no animal burrows were seen, it is possible that some exist. The crest of the dam was well covered with grass, a fescue, about 3 inches high. Examination of a soil sample obtained from the downstream face near the center of the dam indicated the surficial material to be a light brown, silty lean clay (CL) of low-to-medium plasticity.

The grass-covered earth spillway (see Photos 5 and 6) as well as the visible portions of both the upstream (see Photo 4) and downstream (see Photo 7) retaining walls appeared to be in satisfactory condition. A small gully, about 6 inches deep and up to 2 feet in width located near the center of the spillway, that served as a pilot channel extended the length of the crest section. At the downstream end of the crest section, the gully within the spillway channel was extensively eroded and followed a course that carried it

past the left end of the downstream retaining wall (see Photo 7) and beyond, what appeared to be, the intended spillway outlet channel where it joined a natural drainage swale at a point about 25 feet south, or downstream, of the intended channel. A large pile of tree branches that appeared to have been purposely placed covered about two-thirds of the retaining wall. Both the intended outlet channel (see Photo 8) and the natural swale were somewhat overgrown with brush and small trees. A minor quantity of standing water, the origin of which could not be determined, was observed at the junction of the spillway outlet channel and the original stream channel. However, no indication of lake seepage was observed adjacent to the dam or within the original stream channel in the immediate vicinity of the dam.

d. Appurtenant Structures. No appurtenant structures were observed at this dam site.

e. Downstream Channel. Except as noted herein, the channel downstream of the dam within the potential flood damage zone is unimproved. The channel section is irregular and for the most part lined with trees. The channel joins the upstream end of Deerwood Lake No. 1 at a point about 1,000 feet downstream of the Gwenmil Lake Dam. The dam for Deerwood Lake No. 1, MO 30431, lies approximately 2,000 feet downstream of the Gwenmil Lake Dam.

f. Reservoir. At the time of the inspection, the reservoir was approximately 2.2 feet below normal level and the lake water was clear. No significant erosion of the lake banks was evident. The area about the lake is a residential development, well maintained with established lawns. However, as previously indicated, several dense stands of cattail were noted within the reservoir including the area of the spillway approach. The amount of sediment within the lake could not be determined during the inspection; however, due to the turf cover on the area surrounding the lake, it is not expected to be significant.

3.2 EVALUATION

It appears that the original intent was to discharge spillway releases to the man-made channel just downstream of the 8-inch retaining wall at the end

of the crest section rather than to the natural drainage swale located just south of the subdivision's property line. Regardless of the original intent, for lake outflow within the capacity of the spillway, the safety of the dam is not endangered.

The deficiencies observed during the inspection and noted herein are not considered of significant importance to warrant immediate remedial action.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The spillway is uncontrolled. The lake level is governed by precipitation runoff, evaporation, seepage, and the capacity of the uncontrolled spillway.

4.2 MAINTENANCE OF DAM

According to Edward Ward, President, Board of Trustees, the dam receives periodic routine maintenance such as monthly mowing of the grass on the dam crest during the growing season, yearly removal by trapping of muskrats, and restoration of the dam as required at muskrat burrows.

4.3 MAINTENANCE OF OUTLET OPERATING FACILITIES

No outlet facilities requiring operation exist at this dam, and there is no reservoir regulation plan. As previously indicated, a lake drain pipe, capped at the downstream end, was reported by the former owner, Mrs. Mildred Cook, to exist. However, the outlet could not be located during the inspection and, since it is capped, it is presumed that the outlet would be used only to completely drain the lake.

4.4 DESCRIPTION OF ANY WARNING SYSTEMS IN EFFECT

Mr. Ward, who resides near the lake, indicated that the Jefferson County sheriff's office would be notified in the case of an emergency, such as the imminent failure of the dam. The inspection did not reveal the existence of any other type of dam failure warning system.

4.5 EVALUATION

It is recommended that maintenance of the dam also include removal of trees and brush on the downstream face of the dam and the stands of cattails within the reservoir adjacent to the dam and spillway. Measures should also be taken to prevent further erosion of the upstream face at and just above

the normal waterline. It is also recommended that a detailed inspection of the dam be instituted on a regular basis by an engineer experienced in the design and construction of dams and that records be kept of all inspections made and remedial measures taken.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. Design data were not available.

b. Experience Data. The drainage area and lake surface area were determined from topographic data shown on the 1954 USGS Belew Creek, Missouri Quadrangle Map (photorevised 1968 and 1974). The proportions and dimensions of the spillway and dam were developed from surveys made during the inspection. Records of rainfall, streamflow, or flood data for the watershed were not available.

Due to the fact that the watershed for this reservoir is small and since there is no history of excessive reservoir leakage that would adversely affect the normal operating level of the lake, the lake level was assumed to be at normal pool (spillway crest) as a result of antecedent storms prior to occurrence of the probable maximum flood storm and the probabilistic storm.

According to the St. Louis District, Corps of Engineers, the estimated flood damage zone, should failure of the dam occur, extends two miles downstream of the dam. Dam No. 30431, classified as of significant hazard potential by the St. Louis District, lies about 2,000 feet downstream of the Gwenmil Dam.

c. Visual Observations.

(1) The spillway, an excavated earth, dish-shaped section with low concrete retaining walls at the upstream and downstream ends of the crest section, is located at the left, or east, abutment.

(2) Due to the occurrence of some minor erosion at the location of the downstream retaining wall, spillway releases appear to discharge to a natural drainage swale located approximately 25 feet south of the intended outlet channel.

(3) Spillway releases within the capacity of the spillway section should not endanger the dam.

(4) It was reported that the lake is provided with a 3-inch diameter pipe drain, capped at the downstream end. This outlet could not be located at the time of the inspection.

d. Overtopping Potential. The spillway is inadequate to pass the probable maximum flood without overtopping the dam. However, for all practical purposes, the spillway is adequate to pass one-half the probable maximum food and the lake outflow resulting from the 1 percent probability (100-year frequency) flood without overtopping the dam. The results of the dam overtopping analyses are as follows:

(Note: The data appearing in the following table were extracted from the computer output data appearing in Appendix B. Unles otherwise indicated, decimal values have been rounded to the nearest one-tenth in order to prevent assumption of unwarranted accuracy.)

Ratio of PMF	Q-Peak Outflow (cfs)	Max. Lake W.S. Elev.	Max. Depth (Ft.) of Flow over Dam (Elev. 636.2)	Duration of Overtopping of Dam (Hours)
0.50	98	636.23	0.03	0.17
1.00	342	636.8	0.6	0.7
1% Prob. Flood	42	635.7	0	0

The lowest point in the dam crest was found to be elevation 636.2. The flow safely passing the spillway just prior to overtopping was determined to be approximately 94 cfs, which is the routed outflow corresponding to about 48 percent of the probable maximum flood inflow. During peak outflow of the probable maximum flood, the greatest depth of flow over the dam is projected to be 0.6 foot and overtopping is estimated to extend across almost the entire length of the dam. During peak outflow of one-half the probable maximum flood, a very minor amount of overtopping is expected to occur at about station 2+00. Overtopping is not expected as a result of lake outflow resulting from the 100-year storm.

e. Evaluation. The results of the overtopping analyses indicate that the existing spillway is adequate to pass the 1 percent chance (100-year frequency) flood, which is the recommended spillway design flood, without overtopping the dam. This does not mean that floods greater than the recommended spillway design flood will not occur, or that overtopping of the dam as a result of floods on the order of one-half the probable maximum flood, or greater, will not take place.

f. References. Procedures and data for determining the probable maximum flood, the 1 percent probability (100-year frequency) flood and the discharge rating curve for flow passing the spillway are presented on pages B-1 and B-2 of Appendix B. Listings of the HEC-1 (Dam Safety Version) input data for both the probable maximum flood and the 1 percent probability (100-year frequency) flood are shown on pages B-3 through B-5. Computer output data, including unit hydrograph ordinates, tabulation of PMF rainfall, loss and inflow data are shown on pages B-6 through B-9; tabulation of lake surface area, elevation and storage volume is shown on page B-10 and tabulations titled "Summary of Dam Safety Analysis" for the PMF and 1 percent probability (100-year frequency) flood are also shown on page B-10. Values for the spillway rating curve are shown in the table on page B-11.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visual observations of conditions which adversely affect the structural stability of the dam are discussed in Section 3, paragraph 3.1c.

b. Design and Construction Data. No design or construction data relating to the structural stabilty of the dam are known to exist. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Operating Records. No appurtenant structures or facilities requiring operation exist at this dam. According to Mr. Edward Ward, the Owner's representative, no records are kept of the lake level, spillway discharge, dam settlement, or seepage.

d. Post Construction Changes. According to both Mrs. Mildred Cook, the former owner, and Mr. Ward, no post construction changes have been made or have occurred which would affect the structural stability of the dam.

e. Seismic Stability. The dam is located within a Zone II seismic probability area. An earthquake of the magnitude that might occur in this area would not be expected to cause structural damage to a well constructed earth dam of this size provided that static stability conditions are satisfactory and conventional safety margins exist. However, it is recommended that the prescribed seismic loading for this zone be applied in any stability analyses performed for this dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. A hydraulic analysis indicated that the spillway is capable of passing lake outflow of about 94 cfs without the level of the lake exceeding the low point in the top of the dam. A hydrologic analysis of the lake watershed area, as discussed in Section 5, paragraph 5.1d, indicates that for storm runoff resulting from the 1 percent chance (100-year frequency) flood (the recommended spillway design flood for this dam), the lake outflow would be about 42 cfs. Since the capacity of the existing spillway exceeds the recommended spillway design flood, the proportions of the spillway are considered adequate and no revisions are believed necessary. However, this does not imply that floods greater than the recommended spillway design flood will not occur, or that overtopping of the dam as a result of these floods will not take place.

Seepage and stability analyses of the dam were not available for review, and therefore, no judgment could be made with respect to the structural stability of the dam.

Several items were noticed during the inspection that could adversely affect the safety of the dam. These items include trees and brush on the downstream slope of the embankment, an excessively steep (as much as 1v on 1.5h) downstream slope, the lack of adequate slope protection to prevent erosion of the upstream face of the dam, and dense stands of cattails within the reservoir adjacent to the dam and spillway.

b. Adequacy of Information. Due to lack of design and construction data, the assessments reported herein were based on external conditions as determined during the visual inspection. The assessments of the hydrology of the watershed and capacity of the spillway were based on a hydrologic/hydraulic study as indicated in Section 5. Seepage and stability analyses comparable to the requirements of "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Urgency. The remedial measures recommended in paragraph 7.2 for the items concerning the safety of the dam noted in paragraph 7.1a should be accomplished within the near future.

d. Necessity for Phase II. Based on the results of the Phase I inspection, a Phase II investigation is not recommended.

e. Seismic Stability. The dam is located within a Zone II seismic probability area. An earthquake of the magnitude that might occur in this area would not be expected to cause structural damage to a well constructed earth dam of this size provided that static stability conditions are satisfactory and conventional safety margins exist. However, it is recommended that the prescribed seismic loading for this zone be applied in any stability analyses performed for this dam.

7.2 REMEDIAL MEASURES

a. Recommendations. The following actions are recommended.

(1) Obtain the necessary soil data and perform dam seepage and stability analyses in order to determine the structural stability of the dam for all operational conditions. Seepage and stability analyses should be performed by a qualified professional engineer experienced in the design and construction of earthen dams.

b. Operations and Maintenance (O & M) Procedures. The following O & M Procedures are recommended:

(1) Remove the trees and brush that may conceal animal burrows from the downstream face of the dam. Tree roots and animal burrows can provide passageways for lake seepage that could lead to a piping condition and failure of the dam. All holes should be filled with compacted impervious material (clay) and the existing turf cover should be restored if destroyed or missing. Maintain the turf cover at a height that will not hinder inspection of the dam or provide cover for burrowing animals.

(2) Provide some form of protection other than grass for the upstream face of the dam at and above the normal waterline in order to prevent erosion. A grass covered slope is not considered adequate protection to prevent erosion by wave action or by a fluctuating lake level. Loss of embankment material by erosion can impair the structural stability of the dam.

(3) Remove the dense stands of cattails from the area of the reservoir that obstruct the spillway approach and provide cover for burrowing animals. Obstructions within the spillway approach can impede lake outflow resulting in a decrease of spillway capacity that could lead to overtopping and failure of the dam. As previously indicated, animal burrows can provide pathways for lake seepage that could develop into a piping condition.

(4) Provide maintenance of all areas of the dam and spillway on a regularly scheduled basis in order to insure features of being in satisfactory operational condition.

(5) A detailed inspection of the dam should be instituted on a regular basis by an engineer experienced in the design and construction of dams. It is also recommended, for future reference, that records be kept of all inspections made and remedial measures taken.

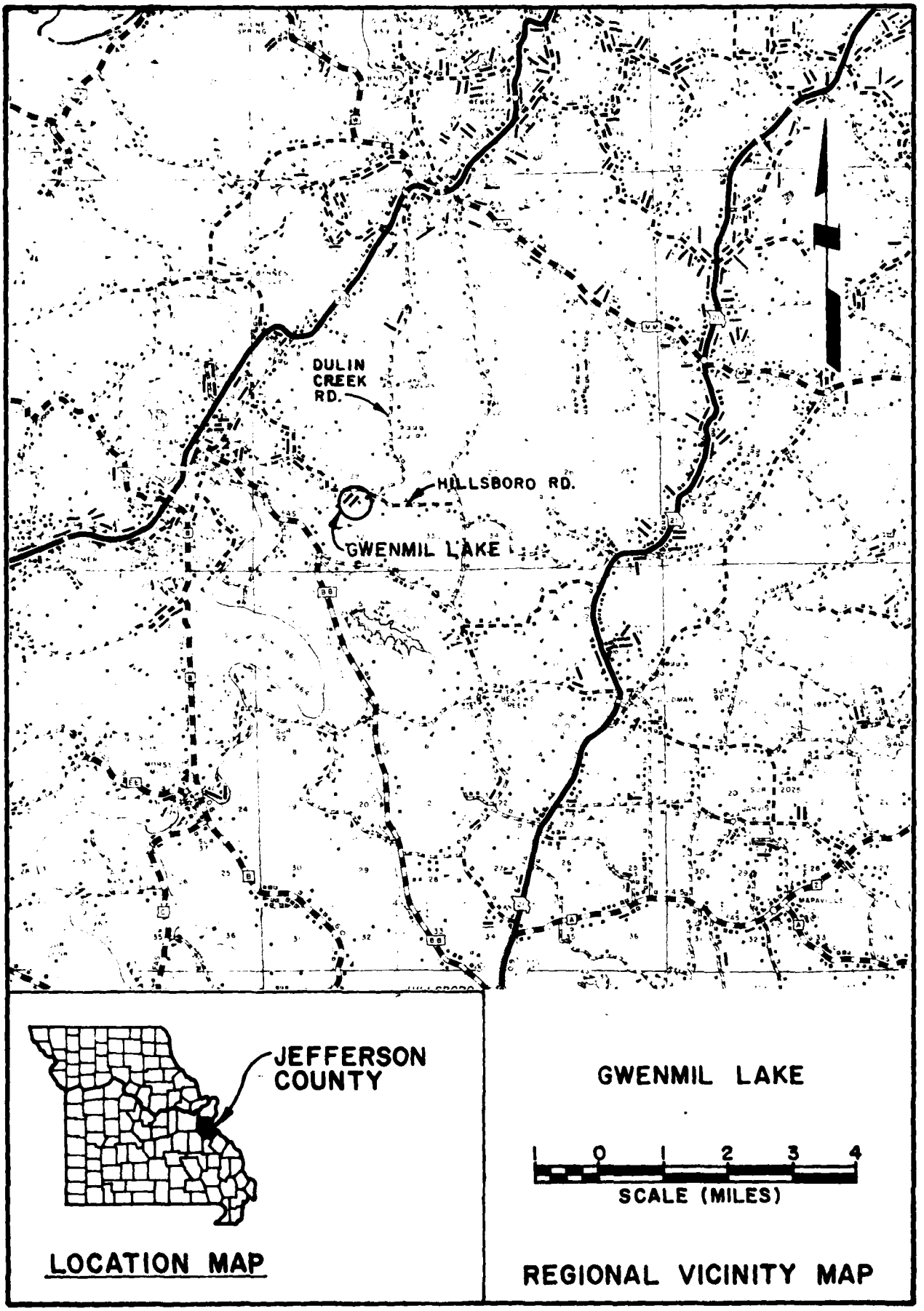
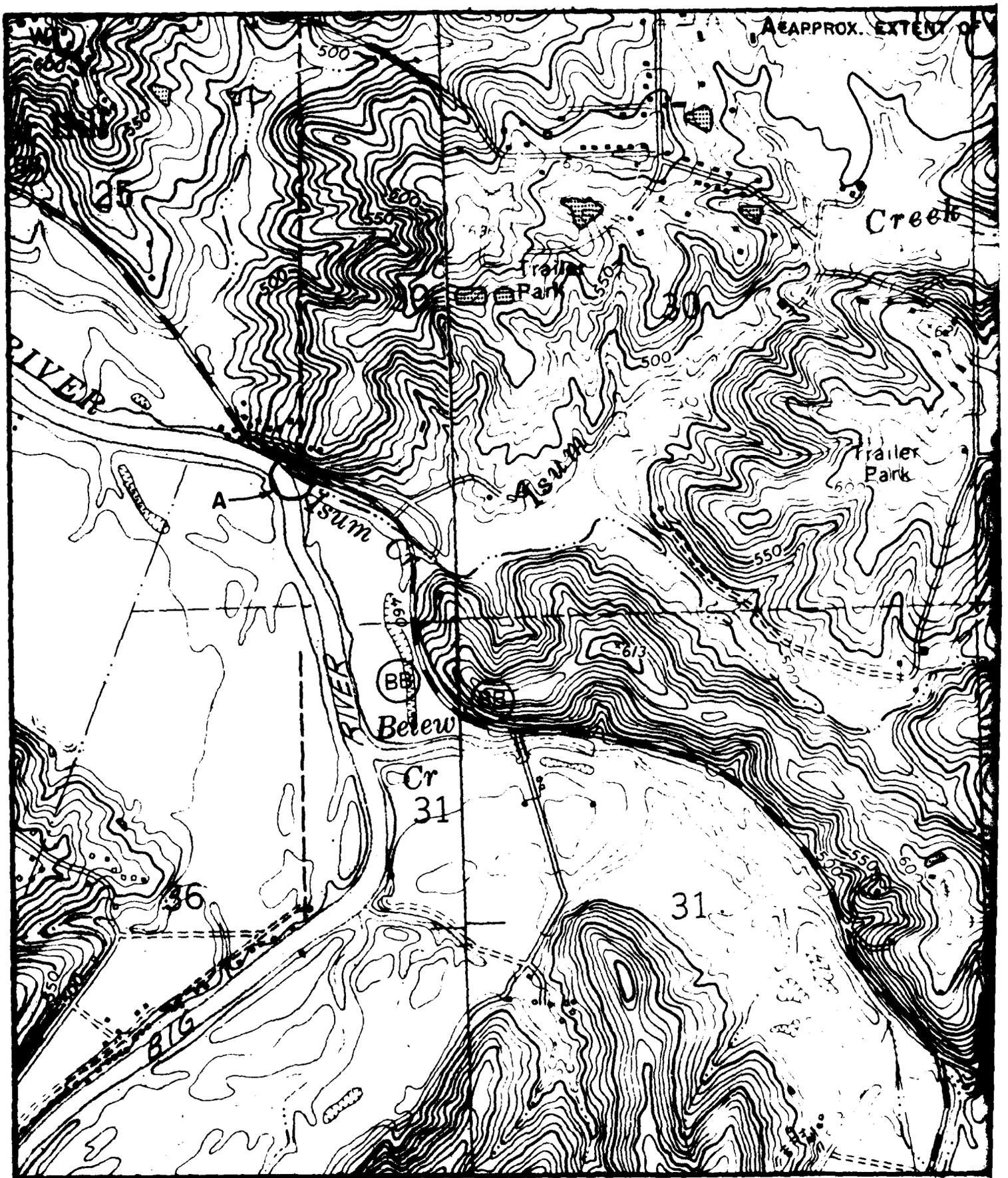
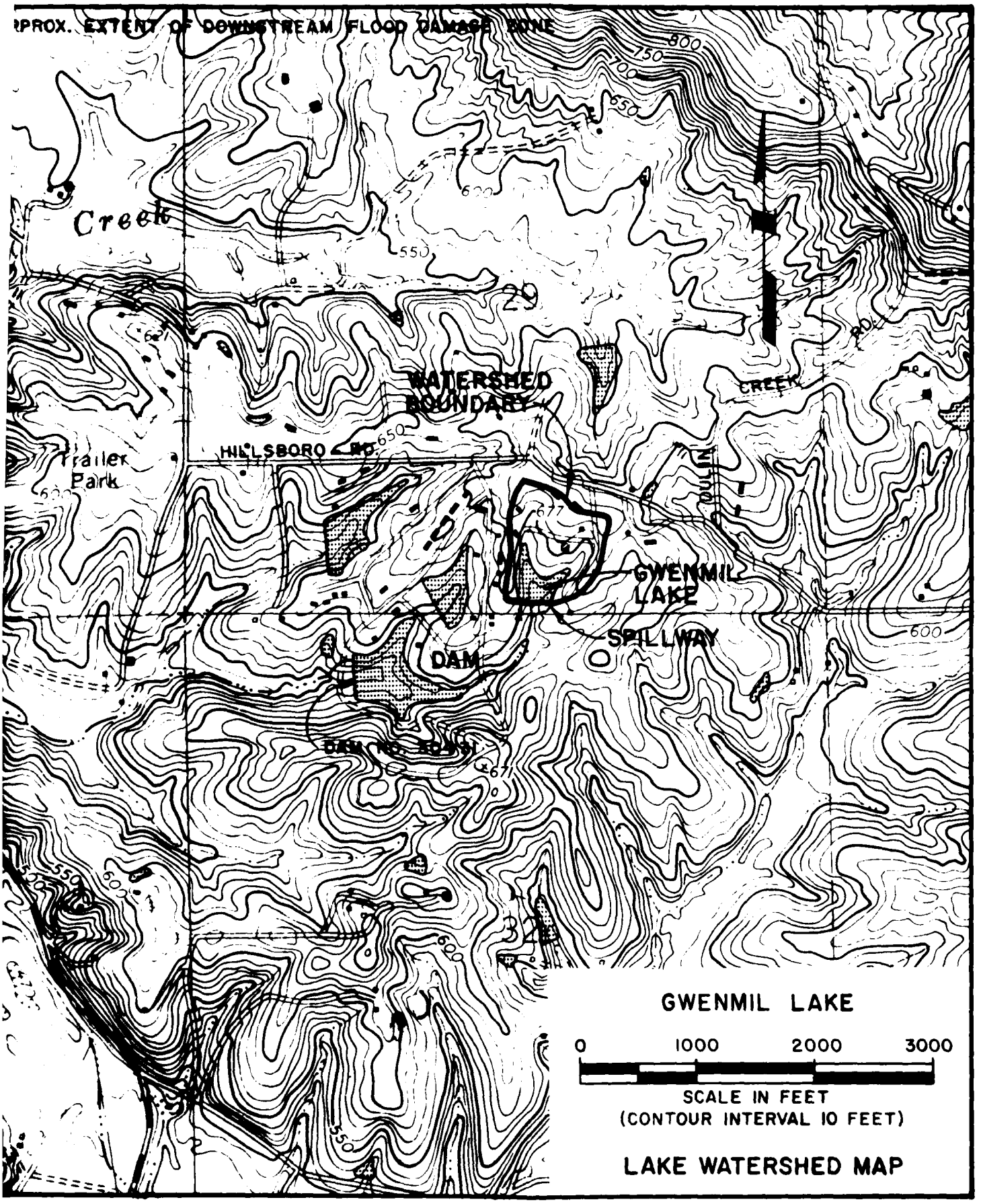

DULIN CREEK RD.
HILLSBORO RD.
GWENMIL LAKE
JEFFERSON COUNTY
LOCATION MAP
GWENMIL LAKE
0 1 2 3 4
SCALE (MILES)
REGIONAL VICINITY MAP

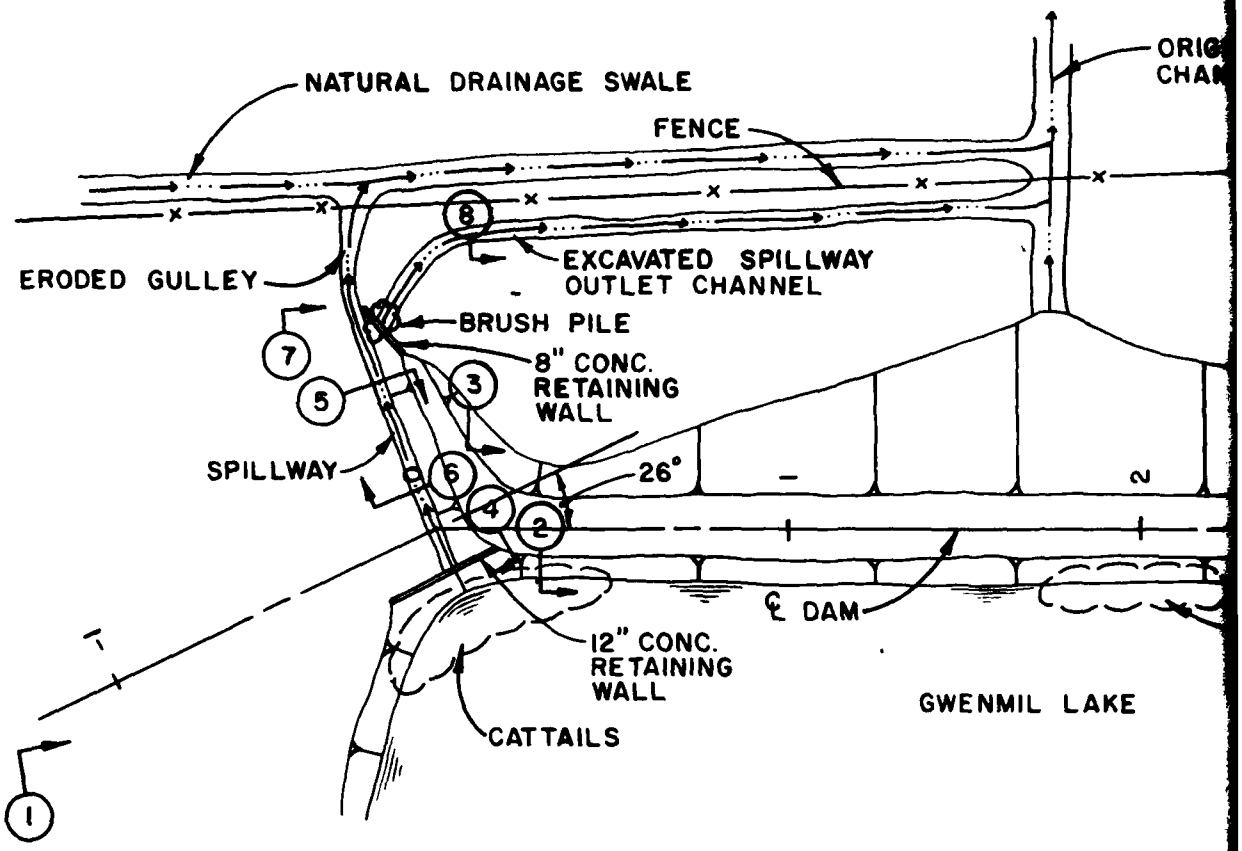
PLATE 1


A APPROX. EXTENT OF
Creek
Trailer Park
Trailer Park
RIVER
Asum
Asum Cr
A
BB
BB
Below
Cr
31
31
36
RIG
500
550
600
650
613


PROX. EXTENT OF DOWNSTREAM FLOOD DAMAGE ZONE
Creek
WATERSHED BOUNDARY
HILLSBORO RD
Trailer Park
GWENMIL LAKE
SPILLWAY
DAM
DAM NO. ROSS
CREEK
29
32
GWENMIL LAKE
0 1000 2000 3000
SCALE IN FEET
(CONTOUR INTERVAL 10 FEET)
LAKE WATERSHED MAP

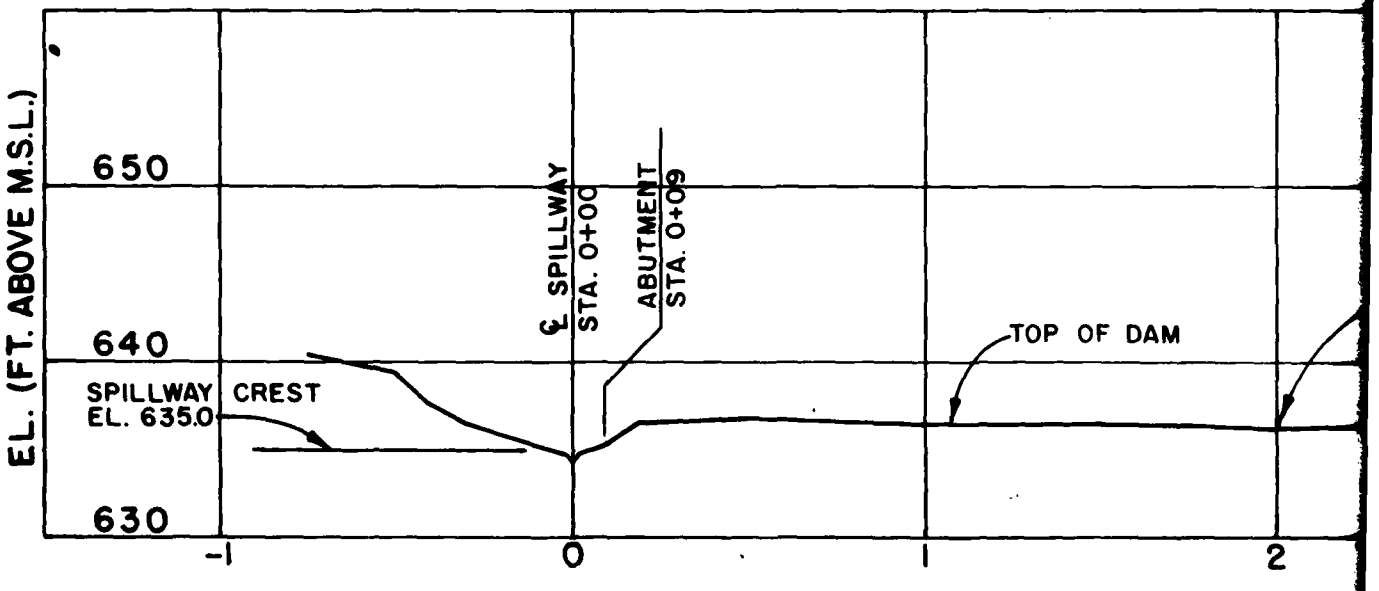
12

PLATE 2



GENERAL PLAN OF D

SCALE: 1" = 50'

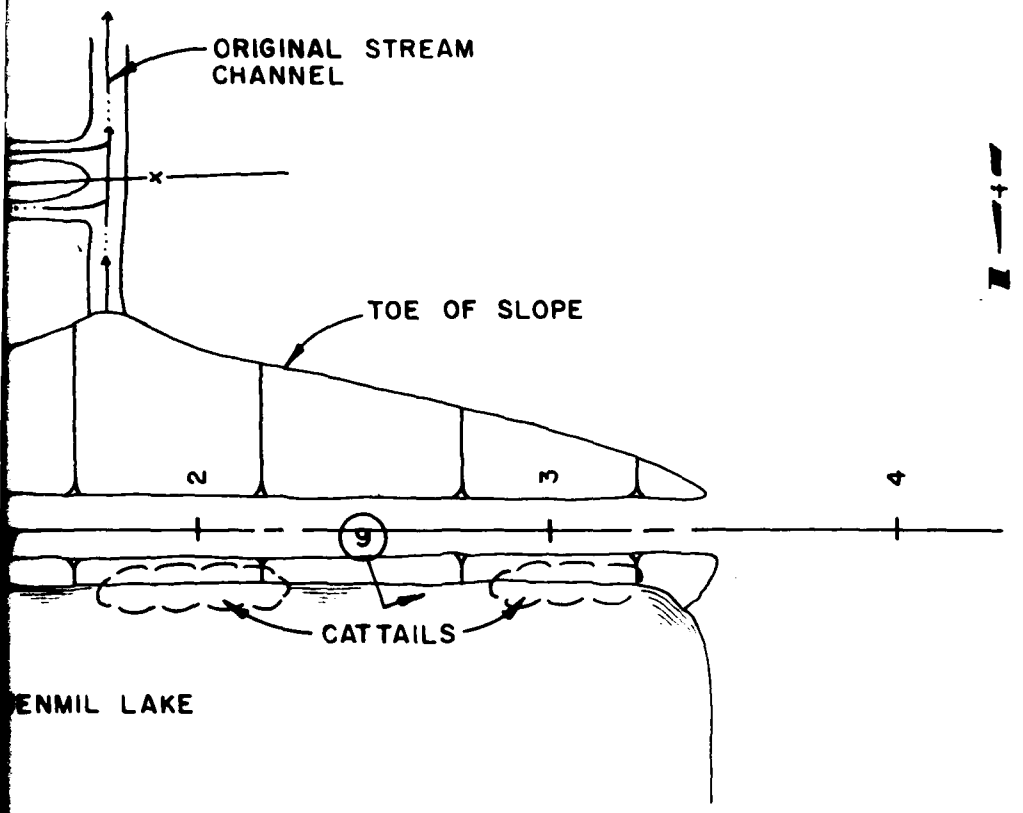


PROFILE DAM CRES

SCALES: 1" = 10'V., 1" = 50'H.

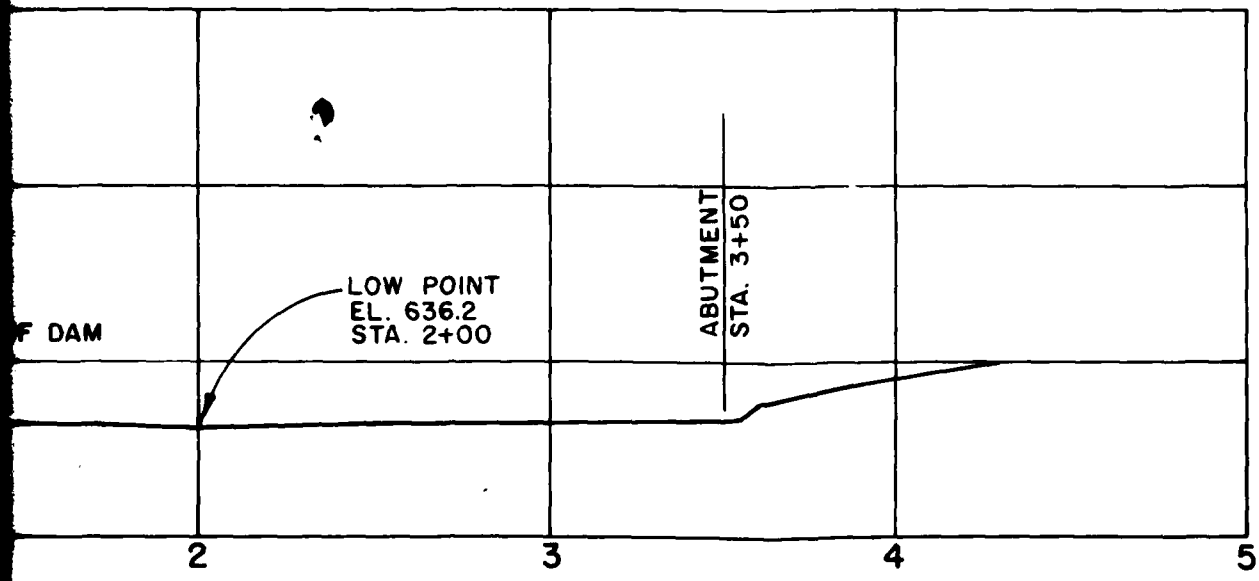
6

PHOTO LOCATION & KEY
(SEE APPENDIX A)



L PLAN OF DAM

SCALE: 1" = 50'

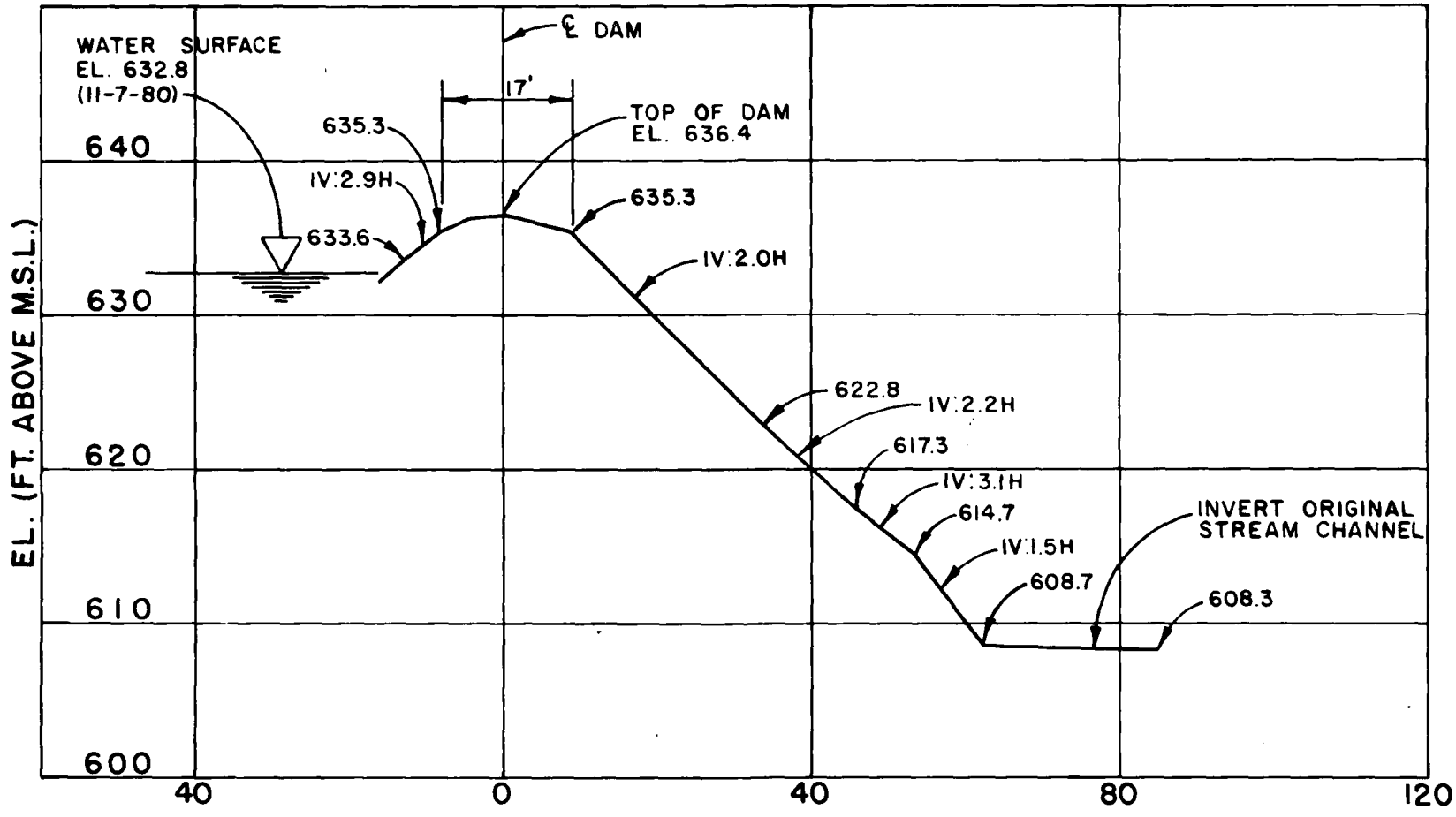


LE DAM CREST

ES: 1" = 10' V., 1" = 50' H.

GWENMIL LAKE
DAM PLAN & PROFILE

Horner & Shifrin, Inc. Jan. 1981



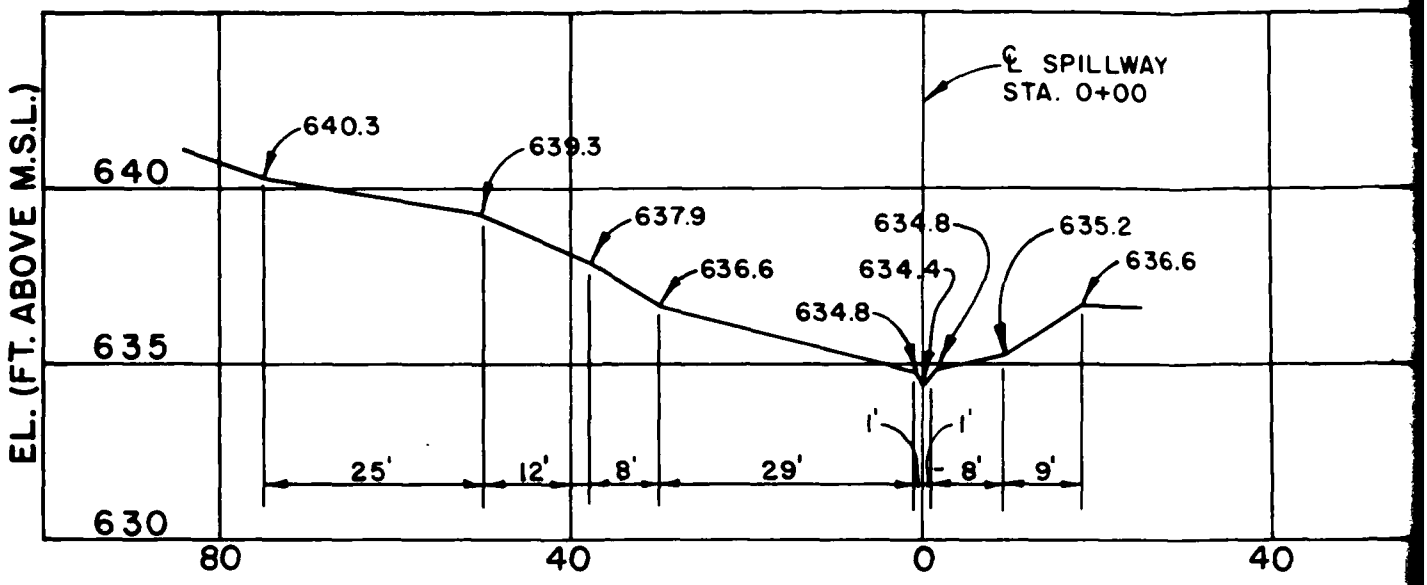
DAM CROSS—SECTION STA. 1+75

SCALES: 1"=10'V., 1"=20'H.

GWENMIL LAKE
DAM CROSS—SECTION

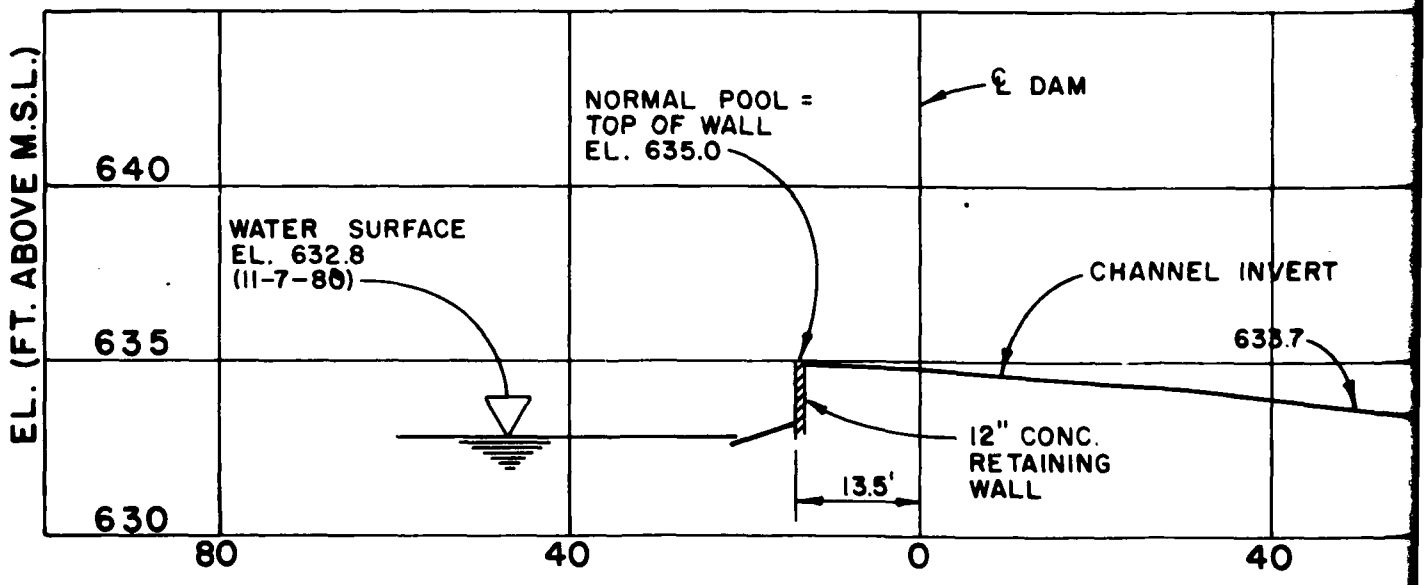
Horner & Shifrin, Inc. Jan. 1981

PLATE 4



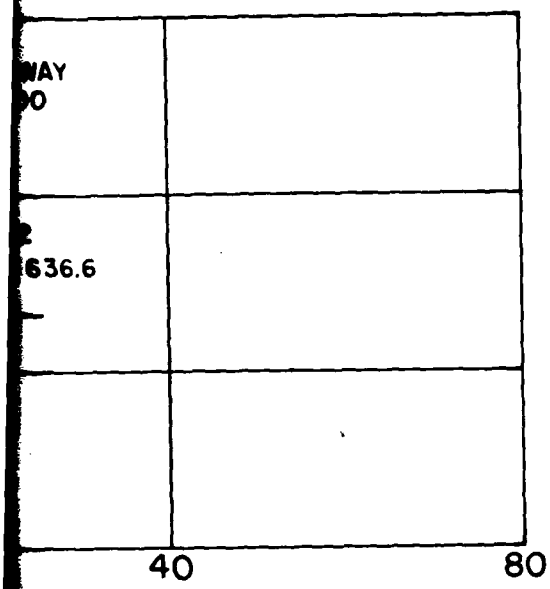
SPILLWAY CROSS-SECTION ℄ DAM

SCALES: 1" = 5' V., 1" = 20' H.

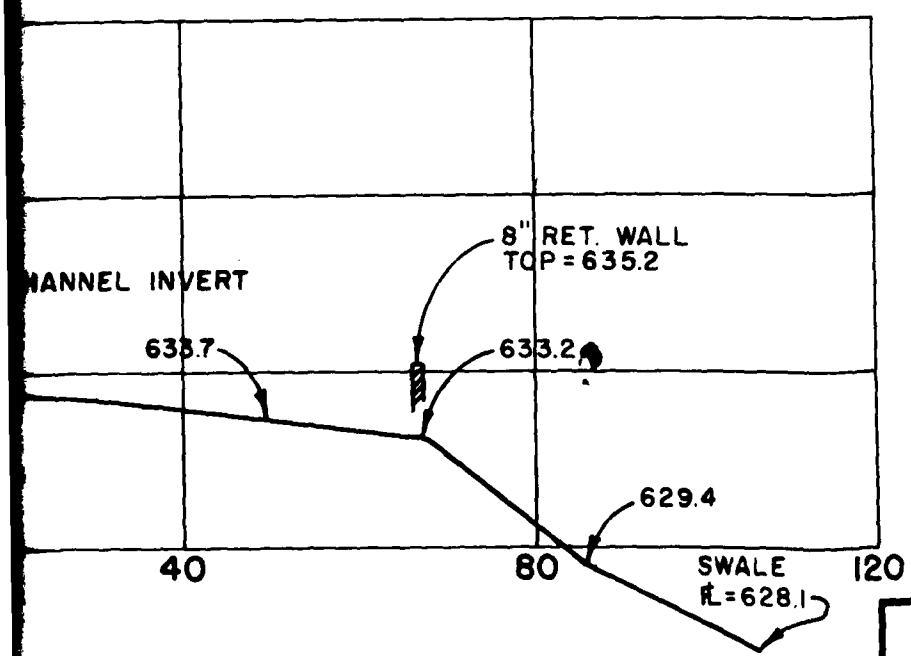


SPILLWAY PROFILE

SCALES: 1" = 5' V., 1" = 20' H.



℄ DAM

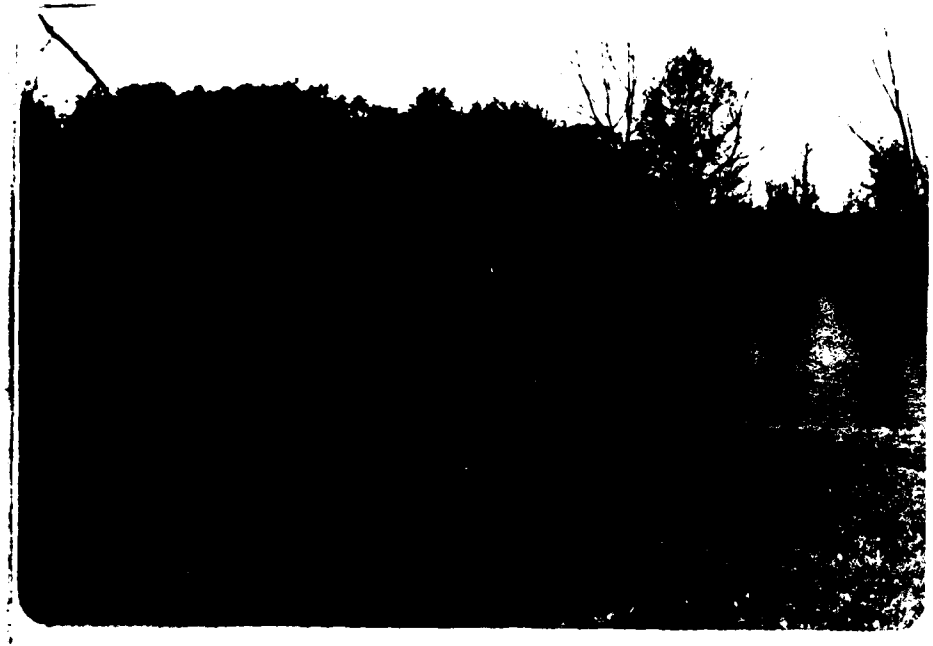


GWENMIL LAKE
SPILLWAY PROFILE &
CROSS-SECTION
Horner & Shifrin, Inc. Jan. 1981

PLATE 5

APPENDIX A

INSPECTION PHOTOGRAPHS



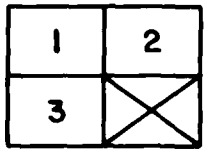


PHOTO KEY

NO.	DESCRIPTION
1	Dam Overview
2	Upstream Face of Dam
3	Downstream Face of Dam

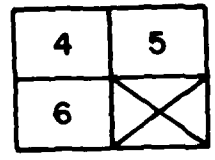
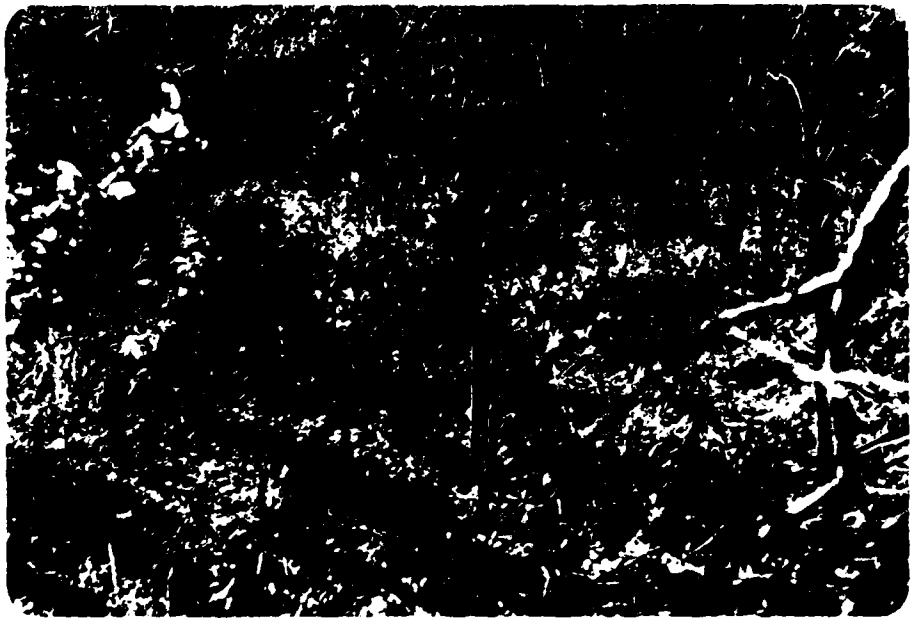
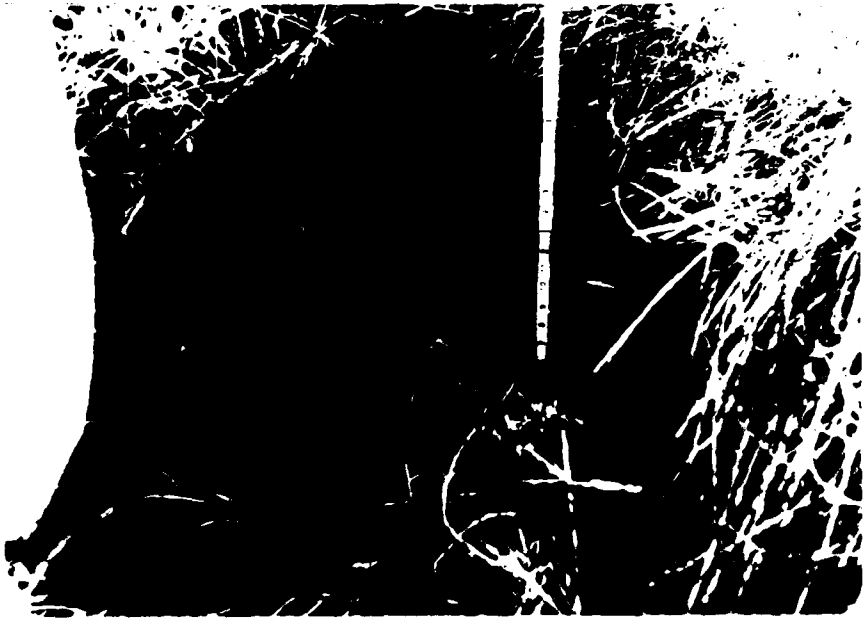


PHOTO KEY

NO.	DESCRIPTION
4	Retaining Wall at Upstream End of Spillway Channel
5	Spillway - Looking Upstream
6	Spillway - Looking Downstream





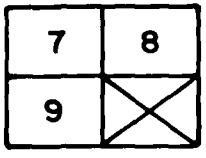


PHOTO KEY

NO.	DESCRIPTION
7	Retaining Wall at Downstream End of Spillway Channel
8	Spillway Outlet Channel
9	Erosion of Upstream Face of Dam

APPENDIX B

HYDROLOGIC AND HYDRAULIC ANALYSES

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

1. The HEC-1 Dam Safety Version (July 1978, Modified 26 February 1979) program was used to develop inflow and outflow hydrographs and dam overtopping analyses, with hydrologic inputs as follows:

a. Probable maximum precipitation (200 sq. miles, 24-hour value equals 25.4 inches) from Hydrometerological Report No. 33. The precipitation data used in the analysis of the 1 percent chance (100-year frequency) flood was provided by the St. Louis District, Corps of Engineers.

b. Storm duration = 24 hours, unit hydrograph duration = 5 minutes.

c. Drainage area = 0.024 square miles = 15 acres.

d. SCS parameters:

Time of Concentration (Tc) = $\left(\frac{11.9L^3}{H}\right)^{0.385}$ = 0.050 hours

Where: T_c = Travel time of water from hydraulically most distant point to point of interest, hours.

L = Length of longest watercourse = 0.114 miles.

H = Elevation difference = 42 feet.

The time of concentration (Tc) was obtained using method C as described in Fig. 30, "Design of Samll Dams", by the United States Department of the Interior, Bureau of Reclamation, and was verified using average channel velocity estimates and watercourse lengths.

Lag time = 0.030 hours (0.60 Tc)

Hydrologic Soil Group = 100% D (Gasconade Series per SCS Missouri General Soil Map and field inspection; 25 percent impervious)

Soil type CN = 80 (AMC II, 100-yr flood)
= 91 (AMC III, PMF condition)

2. The spillway consists of a grass covered, earthen channel of wide and irregular cross-setion. Spillway release rates were determined as follows:

a. Spillway control section was assumed located 13.5 feet downstream of the 12-inch concrete retaining wall at the reservoir.

b. Since the channel slope is mild, s = 0.015, it wa assumed that flow at the control section would occur at normal depth.

c. Flow at normal depth was computed as Q = AV. For various depths, "d", corresponding velocities were determined using the Manning equation,

$V = \frac{1.486\ Ar^{0.67}s^{0.5}}{n}$ for velocity and a channel roughness coefficient, or "n" value of 0.030. Reference "Handbook of Hydraulics" Fifth Edition, by King & Brater, where "A" is the cross-sectional area and V is the velocity of flow for a given depth, "d".

d. Static lake levels corresponding to the various flow values passing the spillway were computed as normal depths plus velocity heads ($d_n + H_v$), and the relationship between lake level and spillway discharge was thus obtained. The procedure neglects the minor insignificant friction losses across the length of the spillway.

e. The spillway discharges for corresponding elevations were entered the computer program on the Y4 and Y5 cards.

3. The profile of the dam crest is irregular and flow over the dam cannot be determined by application of conventional weir formulas. Crest length and elevation data for the dam crest proper were entered into the HEC-1 Program on the $L and $V cards. The program assumes that flow over the dam crest occurs at critical depth and computes internally the flow passing the dam crest and adds this flow to the flow passing the spillway as entered on the Y4 and Y5 cards.

```
A1       ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
A2       HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF GWENMIL LAKE DAM
A3       RATIOS OF PMF ROUTED THROUGH RESERVOIR
B     288        0        5        0        0        0        0        0        0        0
B1      5
J       1        4        1
J1   .45      .48      .50        1
K       0  INFLOW                                                  1
K1       INFLOW HYDROGRAPH
M       1        2    0.024                             1.0                             1
P       0     25.4      102      120      130
T                                                                -1      -91              0.25
W2            0.030
X    -1.0     -.10      2.0
K       1      DAM                                               1
K1       RESERVOIR ROUTING BY MODIFIED PULS
Y                                        1        1
Y1      1                                                  -635.       -1
Y4    635   635.50   635.80   636.25   636.75    637.5    638.5
Y5      0       25       50      100      200      405      750
$A      0        3     4.13      7.2    10.79
$E    612      635      640      650      660
$$    635
$D  636.2
$L      0       50       88      137      182      212      308      332
$V  636.2    636.4    636.5   636.51    636.6   636.61    636.8    636.9
K      99
```

```
A1       ANALYSIS OF DAM OVERTOPPING USING 1% CHANCE FLOOD
A2       HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF GWENMIL LAKE DAM
A3       1% CHANCE FLOOD ROUTED THROUGH RESERVOIR
B     288        0        5                                                4
B1      5
J       1        1        1
J1     1.
K       0   INFLOW                                          1
K1        INFLOW HYDROGRAPH
M       0        2   0.024                      1.0                       1
O     288    7.224
O1  .007     .007     .007     .007     .007     .007     .007     .007     .007     .007
O1  .007     .007     .007     .007     .007     .007     .007     .007     .007     .007
O1  .007     .007     .007     .007     .007     .007     .007     .007     .007     .007
O1  .007     .007     .007     .007     .007     .007     .007     .007     .007     .007
O1  .007     .007     .007     .007     .007     .007     .007     .007     .007     .007
O1  .007     .007     .007     .007     .007     .007     .007     .007     .007     .007
O1  .007     .007     .007     .007     .007     .007     .007     .007     .007     .007
O1  .007     .007     .014     .014     .014     .014     .014     .014     .014     .014
O1  .014     .014     .014     .014     .014     .014     .014     .014     .014     .014
O1  .014     .014     .014     .014     .014     .014     .014     .014     .014     .014
O1  .014     .014     .014     .014     .014     .014     .014     .014     .022     .022
O1  .022     .022     .022     .022     .022     .022     .022     .022     .022     .022
O1  .022     .022     .022     .022     .022     .022     .031     .031     .031     .031
O1  .031     .031     .061     .061     .061     .061     .061     .061     .132     .132
O1  .132     .252     .252     .552     .826     .384     .252     .132     .132     .132
O1  .061     .061     .061     .061     .061     .061     .031     .031     .031     .031
O1  .031     .031     .022     .022     .022     .022     .022     .022     .022     .022
```

1% CHANCE FLOOD (Cont'd)

```
O1   .022    .022    .022    .022    .022    .022    .022    .022    .022    .022
O1   .014    .014    .014    .014    .014    .014    .014    .014    .014    .014
O1   .014    .014    .014    .014    .014    .014    .014    .014    .014    .014
O1   .014    .014    .014    .014    .014    .014    .014    .014    .014    .014
O1   .014    .014    .014    .014    .014    .014    .007    .007    .007    .007
O1   .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
O1   .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
O1   .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
O1   .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
O1   .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
O1   .007    .007    .007    .007    .007    .007    .007    .007
T                                                     -1      -80             0.25
W2          0.030
X    -1.0    -.10     2.0
K       1     DAM                                      1
K1          RESERVOIR ROUTING BY MODIFIED PULS
Y                                    1       1
Y1      1                                          -635.      -1
Y4    635   635.50  635.80  636.25  636.75   637.5   638.5
Y5      0      25      50     100     200     405     750
$A      0       3    4.13     7.2   10.79
$E    612     635     640     650     660
$$    635
$D  636.2
$L      0      50      88     137     162     212     308     332
$V  636.2   636.4   636.5  636.51   636.6  636.61   636.8   636.9
K      99
```

ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF GWENMIL LAKE DAM
RATIOS OF PMF ROUTED THROUGH RESERVOIR

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
283	0	5	0	0	0	0	0	0	0
			JOPER	NWT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 4 LRTIO= 1
RTIOS= .45 .43 .50 1.00

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

	ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
	INFLOW	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	.02	0.00	.02	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	25.40	102.00	120.00	130.00	0.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-91.00	0.00	.25

CURVE NO = -91.00 WETNESS = -1.00 EFFECT CN = 91.00

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= .03

RECESSION DATA
STRTQ= -1.00 QRCSN= -.10 RTIOR= 2.00

TIME INCREMENT TOO LARGE--(NHR IS GT LAG/2)

UNIT HYDROGRAPH 5 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .03 VOL= 1.00
138. 39. 8. 2. 0.

Q						END-OF-PERIOD FLOW						
MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	.00	.01	1.	1.01	12.05	145	.22	.21	.00	32.
1.01	.10	2	.01	.00	.01	1.	1.01	12.10	146	.22	.21	.00	38.
1.01	.15	3	.01	.00	.01	1.	1.01	12.15	147	.22	.21	.00	39.
1.01	.20	4	.01	.00	.01	1.	1.01	12.20	148	.22	.21	.00	40.
1.01	.25	5	.01	.00	.01	1.	1.01	12.25	149	.22	.21	.00	40.
1.01	.30	6	.01	.00	.01	1.	1.01	12.30	150	.22	.21	.00	40.
1.01	.35	7	.01	.00	.01	1.	1.01	12.35	151	.22	.21	.00	40.
1.01	.40	8	.01	.00	.01	1.	1.01	12.40	152	.22	.21	.00	40.
1.01	.45	9	.01	.00	.01	1.	1.01	12.45	153	.22	.21	.00	40.
1.01	.50	10	.01	.00	.01	1.	1.01	12.50	154	.22	.21	.00	40.
1.01	.55	11	.01	.00	.01	1.	1.01	12.55	155	.22	.21	.00	40.
1.01	1.00	12	.01	.00	.01	1.	1.01	13.00	156	.22	.21	.00	40.
1.01	1.05	13	.01	.00	.01	1.	1.01	13.05	157	.26	.26	.00	46.
1.01	1.10	14	.01	.00	.01	1.	1.01	13.10	158	.26	.26	.00	47.
1.01	1.15	15	.01	.00	.01	1.	1.01	13.15	159	.26	.26	.00	48.
1.01	1.20	16	.01	.00	.01	1.	1.01	13.20	160	.26	.26	.00	48.
1.01	1.25	17	.01	.00	.01	1.	1.01	13.25	161	.26	.26	.00	48.
1.01	1.30	18	.01	.00	.01	1.	1.01	13.30	162	.26	.26	.00	48.
1.01	1.35	19	.01	.00	.01	1.	1.01	13.35	163	.26	.26	.00	48.
1.01	1.40	20	.01	.01	.01	1.	1.01	13.40	164	.26	.26	.00	48.
1.01	1.45	21	.01	.01	.01	1.	1.01	13.45	165	.26	.26	.00	48.
1.01	1.50	22	.01	.01	.01	1.	1.01	13.50	166	.26	.26	.00	48.
1.01	1.55	23	.01	.01	.01	1.	1.01	13.55	167	.26	.26	.00	48.
1.01	2.00	24	.01	.01	.01	1.	1.01	14.00	168	.26	.26	.00	48.
1.01	2.05	25	.01	.01	.01	1.	1.01	14.05	169	.32	.32	.00	57.
1.01	2.10	26	.01	.01	.01	1.	1.01	14.10	170	.32	.32	.00	59.
1.01	2.15	27	.01	.01	.01	1.	1.01	14.15	171	.32	.32	.00	60.
1.01	2.20	28	.01	.01	.01	1.	1.01	14.20	172	.32	.32	.00	60.
1.01	2.25	29	.01	.01	.01	1.	1.01	14.25	173	.32	.32	.00	60.
1.01	2.30	30	.01	.01	.01	1.	1.01	14.30	174	.32	.32	.00	60.
1.01	2.35	31	.01	.01	.01	1.	1.01	14.35	175	.32	.32	.00	60.
1.01	2.40	32	.01	.01	.01	1.	1.01	14.40	176	.32	.32	.00	60.
1.01	2.45	33	.01	.01	.01	1.	1.01	14.45	177	.32	.32	.00	60.
1.01	2.50	34	.01	.01	.01	1.	1.01	14.50	178	.32	.32	.00	60.
1.01	2.55	35	.01	.01	.01	1.	1.01	14.55	179	.32	.32	.00	60.
1.01	3.00	36	.01	.01	.01	1.	1.01	15.00	180	.32	.32	.00	60.
1.01	3.05	37	.01	.01	.01	1.	1.01	15.05	181	.20	.20	.00	43.
1.01	3.10	38	.01	.01	.01	2.	1.01	15.10	182	.39	.39	.00	65.
1.01	3.15	39	.01	.01	.01	2.	1.01	15.15	183	.39	.39	.00	71.
1.01	3.20	40	.01	.01	.01	2.	1.01	15.20	184	.59	.59	.00	100.
1.01	3.25	41	.01	.01	.01	2.	1.01	15.25	185	.69	.69	.00	121.
1.01	3.30	42	.01	.01	.01	2.	1.01	15.30	186	1.67	1.67	.00	262.
1.01	3.35	43	.01	.01	.01	2.	1.01	15.35	187	2.76	2.75	.00	450.
1.01	3.40	44	.01	.01	.01	2.	1.01	15.40	188	1.08	1.08	.00	269.
1.01	3.45	45	.01	.01	.01	2.	1.01	15.45	189	.69	.69	.00	160.
1.01	3.50	46	.01	.01	.01	2.	1.01	15.50	190	.59	.59	.00	120.
1.01	3.55	47	.01	.01	.00	2.	1.01	15.55	191	.39	.39	.00	84.
1.01	4.00	48	.01	.01	.00	2.	1.01	16.00	192	.39	.39	.00	75.
1.01	4.05	49	.01	.01	.00	2.	1.01	16.05	193	.30	.30	.00	61.
1.01	4.10	50	.01	.01	.00	2.	1.01	16.10	194	.30	.30	.00	57.

END-OF-PERIOD FLOW (Cont'd)

1.01	4.15	51	.01	.01	.00	2.	1.01	16.15	195	.30	.30	.00	56.
1.01	4.20	52	.01	.01	.00	2.	1.01	16.20	196	.30	.30	.00	56.
1.01	4.25	53	.01	.01	.00	2.	1.01	16.25	197	.30	.30	.00	56.
1.01	4.30	54	.01	.01	.00	2.	1.01	16.30	198	.30	.30	.00	56.
1.01	4.35	55	.01	.01	.00	2.	1.01	16.35	199	.30	.30	.00	56.
1.01	4.40	56	.01	.01	.00	2.	1.01	16.40	200	.30	.30	.00	56.
1.01	4.45	57	.01	.01	.00	2.	1.01	16.45	201	.30	.30	.00	56.
1.01	4.50	58	.01	.01	.00	2.	1.01	16.50	202	.30	.30	.00	56.
1.01	4.55	59	.01	.01	.00	2.	1.01	16.55	203	.30	.30	.00	56.
1.01	5.00	60	.01	.01	.00	2.	1.01	17.00	204	.30	.30	.00	56.
1.01	5.05	61	.01	.01	.00	2.	1.01	17.05	205	.24	.24	.00	47.
1.01	5.10	62	.01	.01	.00	2.	1.01	17.10	206	.24	.24	.00	45.
1.01	5.15	63	.01	.01	.00	2.	1.01	17.15	207	.24	.24	.00	44.
1.01	5.20	64	.01	.01	.00	2.	1.01	17.20	208	.24	.24	.00	44.
1.01	5.25	65	.01	.01	.00	2.	1.01	17.25	209	.24	.24	.00	44.
1.01	5.30	66	.01	.01	.00	2.	1.01	17.30	210	.24	.24	.00	44.
1.01	5.35	67	.01	.01	.00	2.	1.01	17.35	211	.24	.24	.00	44.
1.01	5.40	68	.01	.01	.00	2.	1.01	17.40	212	.24	.24	.00	44.
1.01	5.45	69	.01	.01	.00	2.	1.01	17.45	213	.24	.24	.00	44.
1.01	5.50	70	.01	.01	.00	2.	1.01	17.50	214	.24	.24	.00	44.
1.01	5.55	71	.01	.01	.00	2.	1.01	17.55	215	.24	.24	.00	44.
1.01	6.00	72	.01	.01	.00	2.	1.01	18.00	216	.24	.24	.00	44.
1.01	6.05	73	.06	.05	.01	7.	1.01	18.05	217	.02	.02	.00	41.
1.01	6.10	74	.06	.05	.01	9.	1.01	18.10	218	.02	.02	.00	38.
1.01	6.15	75	.06	.05	.01	9.	1.01	18.15	219	.02	.02	.00	36.
1.01	6.20	76	.06	.05	.01	10.	1.01	18.20	220	.02	.02	.00	33.
1.01	6.25	77	.06	.05	.01	10.	1.01	18.25	221	.02	.02	.00	31.
1.01	6.30	78	.06	.05	.01	10.	1.01	18.30	222	.02	.02	.00	29.
1.01	6.35	79	.06	.05	.01	10.	1.01	18.35	223	.02	.02	.00	27.
1.01	6.40	80	.06	.05	.01	10.	1.01	18.40	224	.02	.02	.00	25.
1.01	6.45	81	.06	.06	.01	10.	1.01	18.45	225	.02	.02	.00	24.
1.01	6.50	82	.06	.06	.01	10.	1.01	18.50	226	.02	.02	.00	22.
1.01	6.55	83	.06	.06	.01	10.	1.01	18.55	227	.02	.02	.00	21.
1.01	7.00	84	.06	.06	.01	10.	1.01	19.00	228	.02	.02	.00	19.
1.01	7.05	85	.06	.06	.01	10.	1.01	19.05	229	.02	.02	.00	18.
1.01	7.10	86	.06	.06	.01	11.	1.01	19.10	230	.02	.02	.00	17.
1.01	7.15	87	.06	.06	.01	11.	1.01	19.15	231	.02	.02	.00	16.
1.01	7.20	88	.06	.06	.01	11.	1.01	19.20	232	.02	.02	.00	15.
1.01	7.25	89	.06	.06	.01	11.	1.01	19.25	233	.02	.02	.00	14.
1.01	7.30	90	.06	.06	.01	11.	1.01	19.30	234	.02	.02	.00	13.
1.01	7.35	91	.06	.06	.01	11.	1.01	19.35	235	.02	.02	.00	12.
1.01	7.40	92	.06	.06	.01	11.	1.01	19.40	236	.02	.02	.00	11.
1.01	7.45	93	.06	.06	.00	11.	1.01	19.45	237	.02	.02	.00	10.
1.01	7.50	94	.06	.06	.00	11.	1.01	19.50	238	.02	.02	.00	10.
1.01	7.55	95	.06	.06	.00	11.	1.01	19.55	239	.02	.02	.00	9.
1.01	8.00	96	.06	.06	.00	11.	1.01	20.00	240	.02	.02	.00	8.
1.01	8.05	97	.06	.06	.00	11.	1.01	20.05	241	.02	.02	.00	8.
1.01	8.10	98	.06	.06	.00	11.	1.01	20.10	242	.02	.02	.00	7.
1.01	8.15	99	.06	.06	.00	11.	1.01	20.15	243	.02	.02	.00	7.
1.01	8.20	100	.06	.06	.00	11.	1.01	20.20	244	.02	.02	.00	6.
1.01	8.25	101	.06	.06	.00	11.	1.01	20.25	245	.02	.02	.00	6.
1.01	3.30	102	.06	.06	.00	11.	1.01	20.30	246	.02	.02	.00	6.

END-OF-PERIOD FLOW (Cont'd)

1.01	8.35	103	.06	.06	.00	11.	1.01	20.35	247	.02	.02	.00	5.
1.01	8.40	104	.06	.06	.00	11.	1.01	20.40	248	.02	.02	.00	5.
1.01	8.45	105	.06	.06	.00	11.	1.01	20.45	249	.02	.02	.00	4.
1.01	8.50	106	.06	.06	.00	11.	1.01	20.50	250	.02	.02	.00	4.
1.01	8.55	107	.06	.06	.00	11.	1.01	20.55	251	.02	.02	.00	4.
1.01	9.00	108	.06	.06	.00	11.	1.01	21.00	252	.02	.02	.00	4.
1.01	9.05	109	.06	.06	.00	11.	1.01	21.05	253	.02	.02	.00	4.
1.01	9.10	110	.06	.06	.00	11.	1.01	21.10	254	.02	.02	.00	4.
1.01	9.15	111	.06	.06	.00	11.	1.01	21.15	255	.02	.02	.00	4.
1.01	9.20	112	.06	.06	.00	11.	1.01	21.20	256	.02	.02	.00	4.
1.01	9.25	113	.06	.06	.00	11.	1.01	21.25	257	.02	.02	.00	4.
1.01	9.30	114	.06	.06	.00	11.	1.01	21.30	258	.02	.02	.00	4.
1.01	9.35	115	.06	.06	.00	11.	1.01	21.35	259	.02	.02	.00	4.
1.01	9.40	116	.06	.06	.00	11.	1.01	21.40	260	.02	.02	.00	4.
1.01	9.45	117	.06	.06	.00	11.	1.01	21.45	261	.02	.02	.00	4.
1.01	9.50	118	.06	.06	.00	11.	1.01	21.50	262	.02	.02	.00	4.
1.01	9.55	119	.06	.06	.00	11.	1.01	21.55	263	.02	.02	.00	4.
1.01	10.00	120	.06	.06	.00	11.	1.01	22.00	264	.02	.02	.00	4.
1.01	10.05	121	.06	.06	.00	11.	1.01	22.05	265	.02	.02	.00	4.
1.01	10.10	122	.06	.06	.00	11.	1.01	22.10	266	.02	.02	.00	4.
1.01	10.15	123	.06	.06	.00	11.	1.01	22.15	267	.02	.02	.00	4.
1.01	10.20	124	.06	.06	.00	11.	1.01	22.20	268	.02	.02	.00	4.
1.01	10.25	125	.06	.06	.00	11.	1.01	22.25	269	.02	.02	.00	4.
1.01	10.30	126	.06	.06	.00	11.	1.01	22.30	270	.02	.02	.00	4.
1.01	10.35	127	.06	.06	.00	11.	1.01	22.35	271	.02	.02	.00	4.
1.01	10.40	128	.06	.06	.00	11.	1.01	22.40	272	.02	.02	.00	4.
1.01	10.45	129	.06	.06	.00	11.	1.01	22.45	273	.02	.02	.00	4.
1.01	10.50	130	.06	.06	.00	12.	1.01	22.50	274	.02	.02	.00	4.
1.01	10.55	131	.06	.06	.00	12.	1.01	22.55	275	.02	.02	.00	4.
1.01	11.00	132	.06	.06	.00	12.	1.01	23.00	276	.02	.02	.00	4.
1.01	11.05	133	.06	.06	.00	12.	1.01	23.05	277	.02	.02	.00	4.
1.01	11.10	134	.06	.06	.00	12.	1.01	23.10	278	.02	.02	.00	4.
1.01	11.15	135	.06	.06	.00	12.	1.01	23.15	279	.02	.02	.00	4.
1.01	11.20	136	.06	.06	.00	12.	1.01	23.20	280	.02	.02	.00	4.
1.01	11.25	137	.06	.06	.00	12.	1.01	23.25	281	.02	.02	.00	4.
1.01	11.30	138	.06	.06	.00	12.	1.01	23.30	282	.02	.02	.00	4.
1.01	11.35	139	.06	.06	.00	12.	1.01	23.35	283	.02	.02	.00	4.
1.01	11.40	140	.06	.06	.00	12.	1.01	23.40	284	.02	.02	.00	4.
1.01	11.45	141	.06	.06	.00	12.	1.01	23.45	285	.02	.02	.00	4.
1.01	11.50	142	.06	.06	.00	12.	1.01	23.50	286	.02	.02	.00	4.
1.01	11.55	143	.06	.06	.00	12.	1.01	23.55	287	.02	.02	.00	4.
1.01	12.00	144	.06	.06	.00	12.	1.02	0.00	288	.02	.02	.00	4.
									SUM	33.02	32.15	.87	6393.
										(839.)(817.)(22.)(181.03)			

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	450.	67.	22.	22.	6379.
CMS	13.	2.	1.	1.	181.
INCHES		25.81	34.34	34.34	34.34
MM		655.56	872.26	872.26	872.26
AC-FT		33.	44.	44.	44.
THOUS CU M		41.	54.	54.	54.

SURFACE AREA=	0.	3.	4.	7.	11.
CAPACITY=	0.	23.	41.	97.	186.
ELEVATION=	612.	635.	640.	650.	660.

SUMMARY OF DAM SAFETY ANALYSIS

PMF

.....	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	635.00	635.00	636.20
STORAGE	23.	23.	27.
OUTFLOW	0.	0.	94.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.45	636.13	0.00	27.	87.	0.00	15.75	0.00
.48	636.19	0.00	27.	94.	0.00	15.75	0.00
.50	636.23	.03	27.	98.	.17	15.75	0.00
1.00	636.79	.59	29.	342.	.67	15.67	0.00

SUMMARY OF DAM SAFETY ANALYSIS

1% CHANCE FLOOD

.....	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	635.00	635.00	636.20
STORAGE	23.	23.	27.
OUTFLOW	0.	0.	94.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	635.70	0.00	25.	42.	0.00	12.25	0.00

HORNER & SHIFRIN, INC.
CONSULTING ENGINEERS
5200 OAKLAND AVE ST. LOUIS, MO 63110

TITLE: Gwynnville Lake Dam, Mo. 31210

SHEET NO B-11 OF

SUBJECT FILE Hydrology

BY [illegible] DATE 5-17-81

CHECKED DATE

JOB NO 2082

TABLE SPILLWAY RATING CURVE VALUES

Spillway W.S. Elev.	Q (cfs)	Area (sf)	Vel. (ft/sec)	H_d (ft.)	Lake W.S. Elev.
635.0	0	—	—	—	635.0
635.2	15.0	5.4	2.78	0.12	635.32
635.6	52.8	13.5	3.91	0.24	635.84
636.2	175.6	32.85	5.34	0.44	636.64
636.6	310 3	49.95	6.21	0.60	637.20
637.0	515.4	69.28	7.44	0.86	637.86
637 4	759.1	29.47	8 78	1.12	638.52
637.9	1125.0	116. 17	9. 68	1.46	639.36

Where: $V = \frac{Q}{A}$ & $H_d = \frac{V^2}{2g}$

$g = 32.2 \text{ ft/sec}^2$